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Strandline Features and Late Pleistocene Chronology of Northwest Vermont

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Trip G-3

STRANDLINE FEATURES AND LATE PLEISTOCENE CHRONOLOGY OF NORTHWEST VERMONT

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Introduction

On this field trip we will examine early Holocene Champlain Sea strandlines along Lake Champlain; then we will see late Pleistocene glacial and glacial lake deposits that indicate both active and stagnant ice retreat in the northern Champlain Valley. Figure 1 is a location map indicating the area under consideration; Figure 2 is a map of the surficial geology of the Enosburg Falls quadrangle; Figure 3 is a north-south plot of features in the northeastern part of the Champlain Valley and adjacent Quebec including data from Wagner (this guidebook, Figure 3, p.322) and McDonald (1968).

Deglaciation of this region began with the retreat of the Laurentide ice sheet from the Green Mountains and Champlain Valley; in the latter there was apparently a lobe of ice which would persist in form as the ice retreated both northward and away from the Green Mountain front. Stewart and MacClintock (1969) discuss the first high-level proglacial lakes to form accompanying initial deglaciation. The presence of local mountain glaciation near Belvidere, Vermont (Wagner, 1970, 1971; Stewart, 1971; Connally, 1971) does not appear to influence deposits or events in the region under discussion here, other than being the source of outwash waters supplying sediment.

As deglaciation proceeded, large proglacial lakes gradually formed in the Champlain Valley at the ice margin, forming various stages of Glacial Lake Vermont, the two principal phases of which were the Coveville and Fort Ann phases, named for their presumed outlets in New York. Work done reported in this article confirms suggestions by McDonald (1968) and by Stewart and MacClintock (1969) that these water levels may have been confluent between the Champlain Valley and the area of southeastern Quebec studied by McDonald. It is proposed that the upper level, the "Sherbrooke phase" of Glacial Lake Memphremagog (McDonald, 1968), is at least in part correlative with a corresponding level in the Champlain Valley, probably the Coveville phase of Lake Vermont of Chapman (1937), and that the lower phase described by McDonald is correlative with the Fort Ann phase of Glacial Lake Vermont. Features to the south (see Wagner, this guidebook, Figure 3, p.322), corresponding reasonably well to the Coveville level of Chapman, are traceable from the vicinity of Jeffersonville and Bakersfield, Vermont (at 720-740 ft.) north and northeastward up into the Missisquoi basin along the mountain front, and thence up the North Branch of the Missisquoi to the vicinity of Bolton Center, Quebec and the Lake Nick col (817 ft.) described by McDonald (1968, p. 668-669). Features belonging to a lower plane, approximately 120-140 feet below the first are likewise traceable from Jeffersonville and Bakersfield (600 ft.) up through the Missisquoi Basin and Sutton Valley to Lake Brome, Quebec. The data, when plotted on a north-south section, form two fairly well-defined curves (Figure 3). McDonald (1968) envisions the Cherry River moraine ice holding back the waters of the Sherbrooke phase of Glacial Lake Memphremagog, then the retreat of the ice beyond the Sutton Mountains, permitting the water level to drop to the lower level, possibly confluent with Fort Ann waters; he also notes (p. 692) that the lower lake system was already in existence at the ice front when the Highland Front moraine was developed. It should be noted that the northernmost point plotted in this article on the upper plane (Coveville-Sherbrooke), No. 20, is a well developed delta on the southeast flank of the Brome-Spruce-Pine mountain area, showing topset-foreset contact at 825 feet; this vicinity would have to be free of ice before Ft. Ann time. On the whole, the findings reported here agree with those of McDonald (1968).

Several things should be noted about Figure 3. First, all points are projected westward, and of necessity involve scatter due to the width of the area considered, and the fact that the isobases do not trend directly east-west. The curves appear to level off northward, as the locations gradually shift to the northeast, becoming more parallel to the isobars. Also, the elevations were determined using topographic maps and bench marks, and of necessity involve both variation and error.

Below the second curve there are a number of features which appear to represent levels intermediate to those of the Champlain Sea. These are best displayed in the Enosburg Falls quadrangle, between the towns of Enosburg and Bakersfield along Vt. Rt. 108, where a set of well defined multiple terraces can be seen (Points 4, 5, 24, 46-49 on Figure 3); these may correspond to intermediate phases between Glacial Lake Vermont and the Champlain Sea, "Lake New York" of Wagner (1969).

Marine waters entered the isostatically depressed Champlain Valley following retreat of the Laurentide ice mass from the St. Lawrence Valley. The oldest marine shell date in the Champlain Valley is from the marine shells at Stop 6, the gravel pit 2 miles south of Frelighsburg, Quebec, dated at 11,740±200 years B.P. The highest marine strandline in the valley proper is straight and parallel to higher (older) proglacial lake water planes (Chapman, 1937; Wagner, 1972). Recent shell dates of lower (younger) marine shoreline deposits allow correlation of these features. Lower

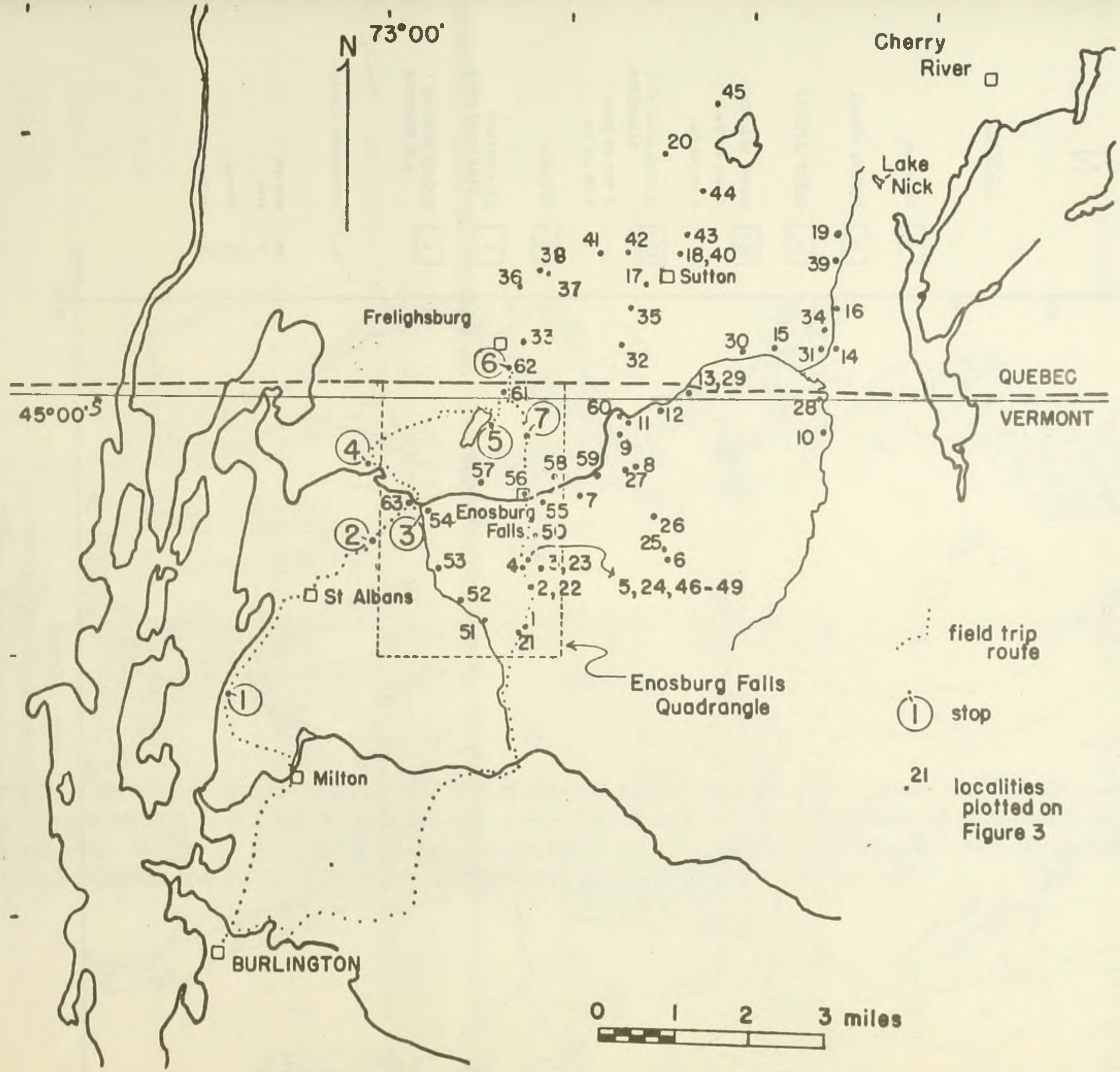
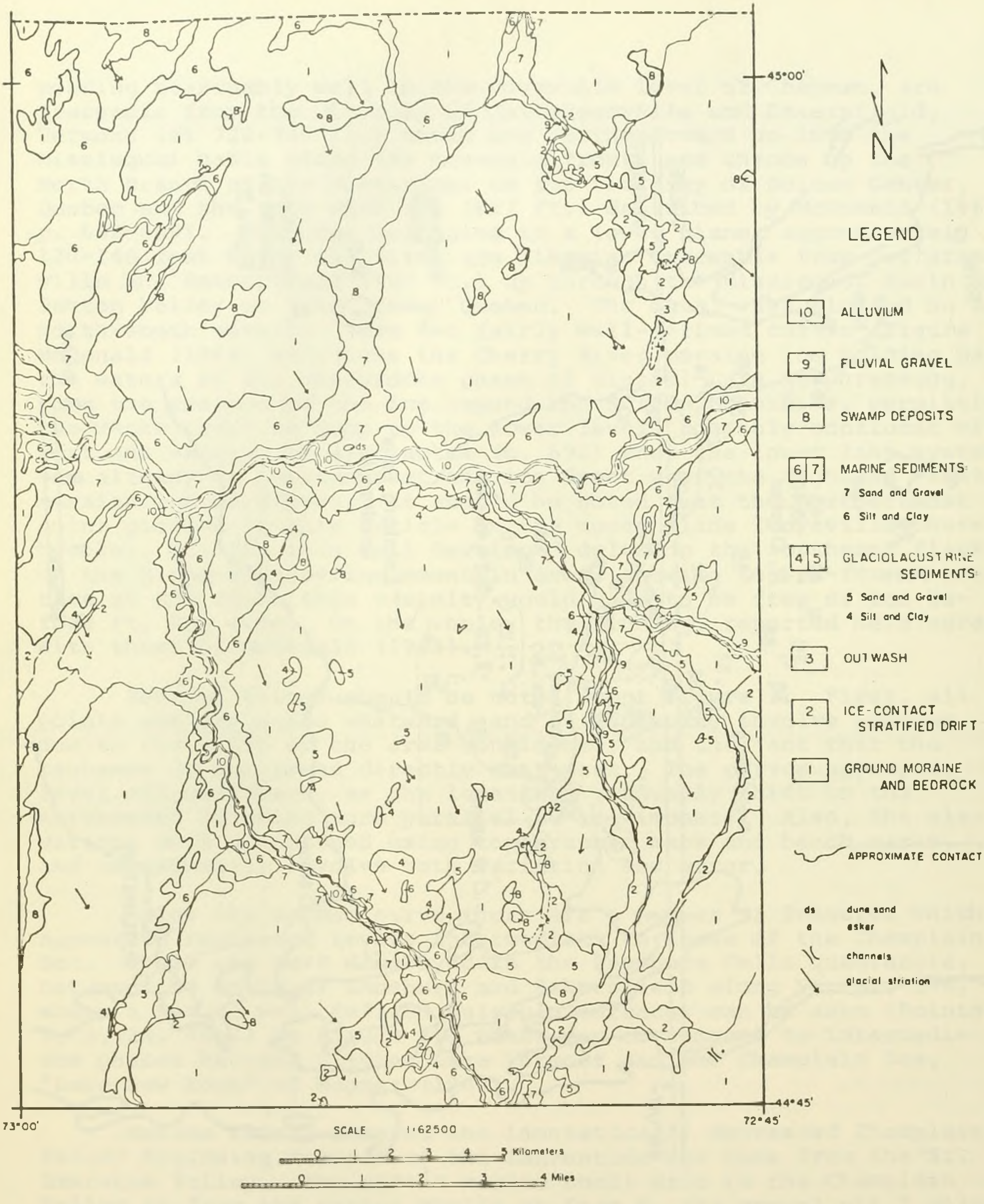


Figure 1. Location map of northwestern Vermont and adjacent southern Quebec.



SURFICIAL GEOLOGY OF THE ENOSBURG FALLS QUADRANGLE

Figure 2

W. R. PARROTT 1971

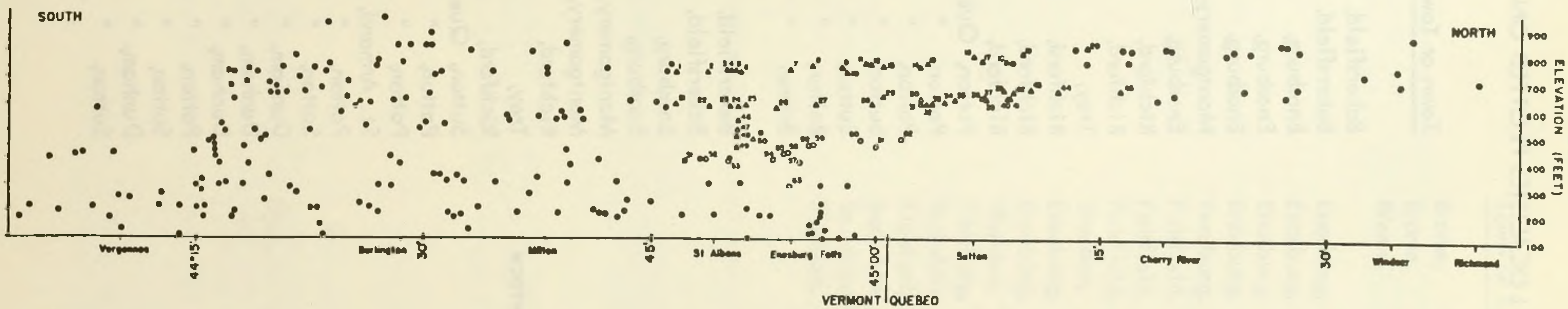


Figure 3. North-south section of shoreline features, northwestern Vermont and adjacent southern Quebec. Open figures pertain to this fieldtrip article (see Table 1 for locations); circles (closed or open) are from Wagner, (Fig. 3, p.), this guidebook; closed hexagons are from McDonald (1968). No data on lowest features in Quebec are shown. Locations are numbered sequentially from south to north.

TABLE 1

NUMBERED LOCALITIES PLOTTED ON FIGURE 3

Number	Feature	Town or Township	Elevation (feet)
1.	delta	Bakersfield, Vt.	720-740
2.	delta-terrace	Bakersfield, "	720-740
3.	beach deposits	Enosburg, "	740
4.	beach deposits	Enosburg, "	740
5.	beach deposits	Enosburg, "	740
6.	delta	Montgomery, "	720-740
7.	delta	Enosburg, "	740
8.	delta	Richford, "	760
9.	delta	Richford, "	740-760
10.	terrace	Troy, "	720-740
11.	delta	Richford, "	760
12.	delta	Richford, "	760
13.	delta	Richford, "	740-760
14.	delta	Potton, Que.	750
15.	delta	Potton, "	750-775
16.	delta	Potton, "	775-800
17.	delta	Sutton, "	750-775
18.	terrace	Sutton, "	750-775
19.	delta-terrace	Bolton, "	800
20.	delta	Brome, "	825
21.	delta-terrace	Bakersfield, Vt.	600
22.	terrace	Bakersfield, "	600
23.	beach deposits	Enosburg, "	600
24.	terrace	Enosburg, "	600
25.	terrace	Montgomery, "	600-620
26.	terrace	Montgomery, "	600
27.	terrace, delta	Richford, "	600-620
28.	beach deposits - terrace	Troy, "	600-620
29.	delta-terrace	Richford, "	640-660
30.	delta	Sutton, Que.	625
31.	terrace	Potton, "	600-625
32.	terrace	Potton, "	600-625
33.	terrace	St. Armand, Que.	600-625
34.	terrace	Potton, "	600-650
35.	terrace-(delta?)	Sutton, "	625
36.	terrace	Dunham, "	625-650
37.	terrace	Dunham, "	625-650
38.	terrace-(delta?)	Dunham, "	625
39.	terrace	Potton, "	650-675
40.	terrace	Sutton, "	625-650
41.	terrace (delta?)	Dunham, "	625-650
42.	delta?	Sutton, "	650

Number	Feature	Town or Township	Elevation
43.	terrace	Brome, Que.	650-675
44.	terrace	Brome, "	650
45.	terrace	Brome, "	650-675
46.			
46.	terrace	Enosburg, Vt.	550
47.	terrace	Enosburg, "	520
48.	terrace	Enosburg, "	490
49.	terrace	Enosburg, "	450
50.	terrace	Enosburg, "	480
51.	delta	Fairfield, "	380-400
52.	delta	Fairfield, "	400
53.	delta	Fairfield, "	380-400
54.	delta	Sheldon, "	400-420
55.	delta	Enosburg, "	420-440
56.	delta	Enosburg, "	440
57.	delta	Sheldon, "	380-400
58.	terrace	Enosburg, "	440
59.	delta	Berkshire, "	440-460
60.	delta	Richford, "	460-480
61.	delta	Berkshire, "	440-460
62.	delta	St. Armand, Que.	450-475
63.	delta	Sheldon, Vt.	300

strandlines show less tilt, indicating that crustal rebound began during the marine episode. Models and details of isostatic adjustment will be discussed at the first stop.

On Figure 3 a number of points related to the Champlain Sea have been plotted; however, data in the literature on Quebec are scanty and have not been included. It should be noted that the marine maximum of 540 feet noted by McDonald (1968, p. 673) fits the plot well and maintains parallelism with the upper two planes. In addition, the well developed features noted by McDonald at 400-420 feet appear to be characteristic of this area as well, although they vary up the Missisquoi basin from 380-400 feet in the west to 420-440 feet in the east.

The sequence of deglaciation affecting the influx and history of the Champlain Sea, however, now appears to be more complex than originally contemplated. Some workers (Cannon, 1964; Stewart and MacClintock, 1969) have proposed an intermediate period of subareal weathering between the Glacial Lake Vermont and the Champlain Sea; recent work by McDonald (1968), Johnson (1970), Wagner (personal communication) and the present study have not detected any weathering zone. However, mappings by Wagner in the St. Albans and Jay Peak Quadrangles, and by Parrott in the Enosburg Falls and Jay Peak Quadrangles have revealed the presence of a till <u>within</u> Champlain Sea sediments in the Missisquoi and Champlain Valleys. Shells found in the Frelighsburg, Quebec pit showing possible disturbance of the deltaic deposits there may record this readvance. The kame complex at Berkshire, Vermont is essentially surrounded by the till, but shows no evidence of disturbance itself, and appears to be related to the wasting away of the ice of this readvance. It is proposed that this readvance be tentatively named the "Missisquoi readvance," as the Missisquoi basin marks its apparent southern limit.

In all, deglaciation appears to have been at first characterized by active retreat, and ended in stagnation-zone retreat with the wasting of the Missisquoi ice.

Acknowledgements

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MAPS

Road Map

Vermont*

U.S.G.S.

1:250, 000

Lake Champlain NL 18-12*

15 Minute Quadrangles

Milton
St. Albans
Enosburg Falls*
Jay Peak
Irasburg
Mt. Mansfield

7 1/2 Minute Quadrangles

Milton
Georgia Plains*
St. Albans Bay*
St. Albans*
Highgate Center*

Canadian (obtainable from the Map Distribution Office
Department of Mines and Technical Surveys
Ottawa)

1:500, 000

Ottawa-Montreal NW 44/76

1:250, 000

Montreal 31-H

1:50, 000

Sutton 31 H/2 West
Sutton 31 H/2 East
Granby 31 H/7 East
Memphremagog 31 H/1 West

* Suggested for field trip

Road Log for Trip G-3

Trip will assemble in parking lot of University of Vermont College of Medicine, off of East Avenue. TRIP LEAVES AT 8:30 A.M. SHARP! AT STOPS, PARK CARS AS FAR OFF ROAD AS POSSIBLE.

Mileage

Cum.	S/S	
0	0	Road log begins. Leave College of Medicine parking lot and turn right onto East Avenue.
0.3	0.3	Intersection with U.S. Rt. 2; turn left onto Rt. 2.
0.8	0.5	Intersection with I-89 entrance; enter on right, after crossing over the interstate, heading north toward St. Albans.
1.9	1.1	Note marine delta sands in South Burlington landfill on right.
2.4	0.5	Note Winooski River gorge on right; 60 feet downcutting into dolostone bedrock since recession of Champlain Sea.
10.6	8.2	Milton Exit; turn left at end of exit ramp, proceed .1 mi. (E), turn left (N) on U.S. Rt. 7. ENTER MILTON 7 1/2' Quadrangle.
14.0	3.4	The southern end of the village of Milton sits on a maximum Champlain Sea delta (360' elevation). Note extensive delta flat north and northwest of the village.
16.7	2.7	Follow Rt. 7 through the village of Milton, noting unique pivot-gate dam at south end of Arrowhead Mountain Lake.
17.5	0.8	Lake Road. Turn left (W). Continue west and north. ENTER GEORGIA PLAINS 7 1/2' Quadrangle.
23.5	6.0	Bear left (W) on Lake Road.
24.8	1.3	You are crossing the Champlain Thrust contact: Dunham over Beldens(?); upper plate forms fault scarp along east shore of Lake Champlain.
25.0	0.2	Sharp right turn; proceed north to:
26.1	1.1	STOP 1. Champlain Sea beach deposit, 160' elevation, C-14 date 10,460 years B.P. on *Macoma balthica* shells. Note washed, imbricate structure of beach gravels.

Mileage

Cum.	S/S	
		What factors could influence the shell C-14 date here ? Discussion of models and details related to isostatic adjustment.
		Continue north along the lake. ENTER ST. ALBANS BAY 7 1/2' Quadrangle.
32.3	6.2	Melville Landing; turn right (SE).
32.8	0.5	Note delta (240' elev.) south of the road; this delta is above the projected 10,460 year-old strandline.
33.2	0.4	Turn left; Proceed north to Mill River.
35.2	2.0	Mill River; note downstream incision, well-developed floodplain and modern delta.
37.4	2.2	Proceed north to Vt. Rt. 36, St. Albans Bay; turn right.
38.2	0.8	Kellog Road; turn left (N). Is there beach topography along this road ? ENTER ST. ALBANS 7 1/2' Quadrangle.
41.9	3.7	Railroad crossing. Beach, wavecut topography on right.
42.1	0.2	Proceed 0.2 miles east to Route 7; turn right (S).
44.7	2.6	Intersection Vt. Rt. 105; turn left (E).
48.2	3.5	Intersection at Greens Corners; turn right (E).
48.6	0.4	Bear left at fork in road (NE).
49.8	1.2	STOP 2. Greens Corners delta and associated channel. Gravel is in kame delta or kame terrace formed when the Laurentide ice margin impinged against the upland. Till occurs at and near the top of the section in places. Similar till also is found at and near the land surface in the field to the west, and in many other localities north and northwest of this site. Northeast of this locality is a linear valley which now is occupied by a small stream. The gravel pit is at the divide, and is the northernmost location of Lake Greens Corners (Wagner, this guidebook). At least two other distinct channels, also approximately coincident with the water plane of

Mileage		
Cum.	S/S	
		Lake Greens Corners, occur in the upland area to the northwest. All of the above channels can be traced northeastward into the Missisquoi Basin where they extend to the level of deltas at the marine limit. Apparently, drainage from Lake Greens Corners was controlled by these channels in Champlain Sea time.
		Proceed northeast along channel and railroad tracks. ENTER ENOSBURG FALLS 15' Quadrangle.
53.2	3.4	Intersection with Vt. Rt. 105; turn right (E).
54.5	1.3	Intersection with road to Sheldon; turn right (S), onto it.
55.2	0.7	Sharp turn in road off to right (S); proceed straight ahead (E) onto dirt road, crossing: a. Black Creek bridge, and b. railroad.
55.5	0.3	STOP 3. Gravel pit in Champlain Sea deltaic material. Sand pit exposes deltaic sand of the marine limit Black Creek delta. In the eastern wall of the pit are exposed several feet of till overlying the deltaic materials. To the south the topset level of the delta is well-defined but the surface deposits are bottomset silt and clay. One well in the region penetrates through the silt-clay material which overlies sand. The delta is believed to be an early Champlain Sea feature with overlying lacustrine sediments from a temporary lake. The till is taken as evidence of glacial control for the lake.
		Return to Rt. 105 via route just taken.
56.5	1.0	Intersection with Rt. 105; turn right (E).
56.9	0.4	Cross Missisquoi River.
60.8	3.9	Intersection with Vermont Rt. 78; turn left (N). East Highgate; sharp turn to right (N). ENTER HIGHGATE CENTER 7 1/2' Quadrangle.
62.2	1.4	Intersection with small road off to left; turn left (SW).
63.1	0.9	STOP 4. Champlain Sea delta gravel pit; Sand and gravel pit on Champlain Sea sediments at the Port Kent level of Chapman (1937).

Mileage

Cum.	S/S	
		Return to intersection with Rt. 78.
64.0	0.9	Turn left (W) onto Rt. 78.
64.7	0.7	Beaulieus Corner; turn right (sharp), to northeast. RE-ENTER ENOSBURG FALLS QUADRANGLE.
66.8	2.1	You are now crossing a plain of Champlain Sea sediments, with several bedrock islands exposed.
67.7	0.9	Browns Corners. Proceed straight ahead (E). Stay on main road.
70.6	2.9	Franklin; intersection with Vt. Rt. 120. Turn left (N).
71.0	0.4	4 Corners; bear right, following Rt. 120 (E).
72.8	1.8	Lake Carmi. This lake rests in a valley containing only bedrock, till, and Champlain Sea sediments; now draining to the north, it originally drained southward following the Champlain Sea influx.
74.3	1.5	Intersection with road to right (on south); turn right.
77.4	3.1	STOP 5. LAKE CARMI STATE PARK. LUNCH. Time for discussion.
		Return to Rt. 120.
82.3	4.9	Intersection with Rt. 120; bear right (ahead) (N).
83.7	1.4	East Franklin; sharp turn to right (E).
84.2	0.5	Intersection with Vt. Rt. 108; turn left (N).
85.6	1.4	International Border; we will stop to be cleared as a group. Please refrain from having any items in your vehicle which might be a source of grief.
86.9	1.3	STOP 6. Gravel pit 2 miles south of Frelighsburg, Quebec. Refer to discussion above. Deltaic material here contained a lens of sand and clay containing disturbed *Macoma balthica* which dated at 11,740 ±200 years B.P.
		Return to Rt. 108; turn right (S).

Mileage

Cum.	S/S	
88.1	1.2	Re-cross International Boundary; we will stop to be let back into the United States.
89.5	1.4	Intersection of Rt. 120 with Rt. 108; bear left, toward West Berkshire (S).
90.1	0.6	Gravel pits in gorge to right contain fluvial gravels; This area drained an upland lake which we will see shortly.
90.3	0.2	West Berkshire.
90.5	0.2	Intersection with dirt road on right (S) side of Rt. 108. Turn right.
92.2	1.7	You are now driving through a kame field mantled by lacustrine sediments; drainage was down through the gorge we just came through.
92.8	0.6	Intersection with road between Berkshire and Enosburg Falls. Turn right (S).
92.9	0.1	The hills in front of you are part of the massive kame field in this area.
93.4	0.5	STOP 7. Gravel pit in Berkshire kame field. Kames in this area rise 200 feet above the surroundings in places and are quite extensive. This pit is the best exposure at the present time. Sediments show massive deposition of sands and gravels from stagnant melting ice, and are characterized by normal faulting. None, however, show evidence of thrusting or other disturbance as far as ice movement is concerned. To the southeast, south, and southwest, along the Missisquoi and Champlain Valleys, Champlain Sea sediments contain a till; this area shows no disturbance however: hence these deposits are interpreted as being post-Missisquoi readvance in age, probably related to stagnation of the ice of the readvance.

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This stop officially concludes the field trip. The route southward suggested below, via Vt. Rts. 108 and 15, passes through Enosburg Falls, Jeffersonville, and Cambridge.

The following log incorporates several features of significance along the return route:

Mileage

Cum.	S/S	
93.5	0.1	Turn right as you leave the gravel pit, and proceed south.
96.6	3.1	Intersection with Vt. Rt. 105. Turn right onto Rt. 105 (W).
97.1	0.5	Enosburg Falls, elevation 422 ft. resting on Champlain Sea deltaic sediments.
97.4	0.3	Intersection where Rt. 105 bears right (W), and Rt. 108 continues straight ahead (S). Proceed straight ahead.
100.0	2.6	West Enosburg; From here on, for the next 4 miles, the valley of Tyler Branch and The Branch contains at least 6 levels (see Figure 3, points 4, 5, 24, 46-49), from the upper lacustrine ("Coveville") to the Champlain Sea. These are clearly visible as you drive along the length of the valley ahead.
104.7	4.7	Browns Pond. Above you to the left is a kame terrace which extends southward, merging into the Bakersfield delta at 740', later reworked to 600' during "Ft. Ann."
106.7	2.0	Bakersfield. The town is built upon the 740' surface.
107.5	0.8	On southern side of valley, if you turn and look back to the right (NW) you can see the 600 foot surface in deltaic deposits south of Bakersfield. ENTER MT. MANSFIELD 15' Quadrangle.
110.7	3.2	Off to right, in the floor of the valley with a small farm resting on it, is a small moraine containing cobbles and Champlain Sea sediment, and which may mark the southern limit of the readvance; here a minor lobe extended down the Missisquoi Black Creek Valley from the northwest.
112.7	2.0	You are now in the Black Creek Valley, which was a channel southward at one time for glaciofluvial waters; the glaciofluvial sediments are mantled first, by lacustrine sediments, and then by Champlain Sea sediments.
118.0	5.3	Intersection with Vt. Rt. 109; bear right, staying on Rt. 108.
119.5	1.5	Intersection with Vt. Rt. 15. Turn right (W),

Mileage		
Cum.	S/S	
		toward Cambridge.
121.9	2.4	Cambridge bridge; turn left (S), across bridge, following Rt. 15 into the town of Cambridge.
122.9	1.0	Intersection with Vt. Rt. 104.

2 choices:

1. Bear left, and follow Rt. 15 through Underhill, Essex Center, and Essex Junction to Interstate 89 and Burlington.

2. Proceed straight ahead along Rt. 104 to Fairfax, and turn left (W) onto 104A, 2 miles beyond toward Milton, along the Lamoille River and Arrowhead Mountain Lake; turn right onto U.S. Rt. 7 at intersection with Rt. 9, then onto I-89, and south toward Burlington and points beyond.

REFERENCES

Cannon, W. F., 1964, The Pleistocene geology of the Enosburg Falls Quadrangle, Vermont: A report to the State Geologist. On open file at the Vermont Geol. Survey, 13 p.

Chapman, D. H., 1937, Late-glacial and postglacial history of the Champlain Valley: Am. Jour. Sci., v. 34, p. 89-124.

Connally, G. G., 1971, Pleistocene mountain glaciation, Northern Vermont: Discussion: Geol. Soc. America Bull., v. 82, p. 1763-1766.

Connally, G. G., and Sirkin, L. A., 1971, Luzerne readvance near Glens Falls, New York: Geol. Soc. America Bull., v. 82, p. 989-1008.

Gadd, N. R., 1964, Moraines in the Appalachian region of Quebec: Geol. Soc. America Bull., v. 75, 1249-1254.

Johnson, P. H., 1970, The surficial geology and Pleistocene history of the Milton Quadrangle, Vermont. Unpublished M. S. thesis, University of Vermont.

McDonald, B. C., 1968, Deglaciation and differential postglacial rebound in the Appalachian region of south-eastern Quebec: Jour. Geology, v. 76, p. 664-677.

McDonald, B. C., and Shilts, W. W., 1971, Quaternary stratigraphy and events in southeastern Quebec: Geol. Soc. America Bull., v. 82, p. 683-698.

Stewart, D. P., 1961, The glacial geology of Vermont: Vermont Geol. Survey Bull., no. 19, 124 p.

Stewart, D. P., and MacClintock, P., 1964, The Wisconsin stratigraphy of northern Vermont: Am. Jour. Sci., v. 262, p. 1089-1097.

Stewart, D. P., and MacClintock, P., 1969, The surficial and Pleistocene history of Vermont: Vermont Geol. Survey Bull., no. 31, 251 p.

Stewart, D. P., 1971, Pleistocene mountain glaciation, northern Vermont: Discussion: Geol. Soc. America Bull., v. 82, p. 1759-1760.

Wagner, W. P., 1969, The late Pleistocene of the Champlain Valley, Vermont: New York State Geol. Assoc. Guidebook, 40th Annual Meeting, p. 65-80.

Wagner, W. P., 1970, Pleistocene mountain glaciation, northern Vermont: Geol. Soc. America Bull., v. 81, p. 2465-2470.

Wagner, W. P., 1971, Pleistocene mountain glaciation, northern Vermont: Reply: Geol. Soc. America Bull., v. 82, p. 1761-1762.

Wagner, W. P., 1972, Ice Margins and Water Levels in Northwestern Vermont: N.E.I.G.C. Guidebook, 1972, Burlington, p.